Russian Health Studies Program
Peer Reviewed Publications and Outcomes
December 31, 2019

Project Number	Project Name	U.S. PI	Russian PI	Number of Peer-Reviewed Publications	Outcomes
1.1	**Techa River Population Dosimetry** 1999-2003 2004-2006 2007-2009 2010-2014 2015-2018 **Development of Dosimetry System for Southern Urals Populations Exposed to Radiation** 2019-2022 **Ongoing**	Bruce Napier *Pacific Northwest National Laboratory-Battelle*	Marina Degteva *Urals Research Center for Radiation Medicine*	152	This project provides the foundation for the derivation of radiation risk from studies of the Techa River Cohort. It provides the dosimetry data for Project 1.2b, *Techa River Population Cancer Morbidity and Mortality*, and for related studies of the U.S. National Cancer Institute and the European Commission. This study is important because it addresses the question of radiogenic risk from dose received at low dose rates. In addition, this project is providing valuable, new information for improving dose estimation from the intake of ^{90}Sr. The Techa River Dosimetry System (TRDS)-2017D (deterministic) and TRDS-2017MC (stochastic) calculations have been completed, with the exception of some enhanced bone dosimetry. Current work emphasizes calculation of individual external dose based upon the location of a person's home, inclusion of additional exposure pathways, including atmospheric transport from Mayak stack releases developed by Project 1.4, *Reconstruction of Dose to Residents of Ozersk from Mayak Operations*, and enhancement of the stochastic version of the dosimetry system with full evaluation of uncertainty in individual doses.

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1.2a	**Data Preservation at URCRM** 1997-2005 **Completed**	Donna Cragle *Oak Ridge Institute for Science and Education*	Nikolai Startsev *Urals Research Center for Radiation Medicine*	1	This completed project established a document imaging system at URCRM for preserving valuable medical records of residents of the Southern Urals region exposed to radiation due to the operations of the Mayak facility and environmental releases. These documents contain information from 1951 to the present with details of medical examinations, individual dose measurements, addresses, causes of death, and other data necessary for epidemiologic studies and dose reconstruction. Computer scanning equipment was purchased, installed, and later updated. Scanning, verification, indexing, and creation of a computer database of the scanned documents were completed.

Project Number	Project Name	U.S. PI	Russian PI	Number of Peer-Reviewed Publications	Outcomes
1.2b	**Techa River Population Cancer Morbidity and Mortality** 1997-2003 2004-2006 2007-2009 2010-2014 2015-2018 2019-2023 **Ongoing**	Daniel Stram, *University of Southern California*	Alexander Akleyev and Ludmila Krestinina *Urals Research Center for Radiation Medicine*	30	The combined work of Projects 1.1, *Techa River Population Dosimetry*, and 1.2b, *Techa River Population Cancer Morbidity and Mortality*, addresses the important question of the validity of the dose-response model (linear, non-threshold) used in the development of radiation-protection standards, particularly as applied to radiation delivered at low dose rates. The Techa River Cohort (TRC) reflects a general population exposed to moderate doses of radiation at low dose rates 50 years ago. Preliminary results using the Techa River Dosimetry System (TRDS)-2016D (deterministic) indicate an excess in leukemia and solid cancer risks in this population. Recent work has included use of new data sources to improve follow-up of participants. As with Project 2.2, *Mayak Worker Cancer Mortality*, researchers are currently refining computational and epidemiological methods to incorporate the Monte Carlo multiple realization dosimetry that is the basis of the TRDS-2016MC (stochastic). Researchers will use the deterministic and stochastic versions of the Southern Urals Populations Exposed to Radiation (SUPER-DS) as soon as enhanced bone dosimetry has been completed. The TRDS-2016MC mean doses are now being used by investigators for risk analysis. The East Urals Radioactive Trace cohort (EURTC) is now being jointly analyzed with the TRC using similar dosimetry.

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1.4	**Reconstruction of Dose to the Residents of Ozersk from Mayak Operations** 2003-2004 2005-2009 2013 **Completed**	Bruce Napier *Pacific Northwest National Laboratory-Battelle*	Yuri Mokrov *Mayak Production Association*	9	This completed project is concerned with the reconstruction of doses to the residents of Ozersk from the airborne radionuclide emissions from Mayak. Focus is on the emission of ^{131}I and dose to the thyroid glands of children. Data may be used to support a potential epidemiologic study of thyroid cancer in children sponsored by the National Cancer Institute. This should help resolve the dichotomy between the studies at Hanford (no observed effect) and Chernobyl (large effect). The project and associated documentation was completed in 2013.

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2.2	**Mayak Worker Cancer Mortality** 1997-2001 2002-2004 2005-2007 2008-2012 2013 2014-2018 2019-2023 **Ongoing**	Daniel Stram *University of Southern California*	Mikhail Sokolnikov *Southern Urals Biophysics Institute*	13	This project is the first to demonstrate statistically significant associations between occupational exposure to plutonium (Pu) and lung, liver, and bone cancer. Dose-response analyses based on the Mayak Worker Doses 2005 database have been conducted for lung, liver, and bone cancer and express the excess relative risk as a function of Pu dose, external dose, sex, and attained age. Statistically significant dose-response relationships for external dose have also been demonstrated for leukemia; all solid cancer excluding lung, liver, and bone cancer; and lung cancer. Researchers also published cancer risk estimates for cancers other than lung, liver, and bone based on the Mayak Worker Dosimetry System (MWDS)-2008. They are now analyzing risks using MWDS-2013, which provides, instead of a single dose estimate, many realizations of possible true dose given uncertainties in dose determinants. A paper describing a statistical strategy for the incorporation of the dosimetry uncertainty characterized by the multiple realizations of dose into future epidemiological dose-response analysis was published in 2015. Researchers are refining this method, have simplified several key calculations while improving the statistical behavior of their approach, and are developing software to use these methods initially in an analysis of lung cancer data. MWDS-2016 plutonium doses (rather than MWDS-2013) are now being used in lung cancer risk analysis. Investigators are beginning to work with the preliminary Job Exposure Matrix doses now being provided by Project 2.4.

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2.4	**Mayak Worker Dosimetry** 1998-2000 2001-2003 2004-2006 2007-2009 2009-2013 2014-2016 2017-2019 **Ongoing**	Bruce Napier *Pacific Northwest National Laboratory-Battelle*	Alexander Efimov (internal dosimetry) *Southern Urals Biophysics Institute*	85	In addition to providing the dosimetric data for Project 2.2, *Mayak Worker Cancer Mortality*, this project has enhanced the understanding of Pu metabolism in the human body and improved the biokinetic models for assessing dose from Pu uptakes. These outcomes will be of direct benefit to DOE in improving the determination of dose to DOE workers from Pu exposure. Additionally, this project has improved the interpretation of worker external dosimetry and developed improved methods of estimating organ doses based on dosimeter results. These improved methods can be applied to the evaluation of worker dose at DOE facilities. This project also developed important relationships for the role of medical x-rays for worker exposure. Researchers completed the Mayak Worker Dosimetry System (MWDS)-2013 for 25,757 workers hired between 1948 and 1982, with full stochastic uncertainty analyses, which is being used to develop cancer and non-cancer risk estimates. Enhancements for MWDS-2016 have been completed. Work for MWDS-2018 includes incorporation of a Job Exposure Matrix approach and development of a Synthetic Cohort for investigating dosimetric and epidemiologic questions.

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2.5	**Improved Plutonium Dose Assessment Methods for Mayak Workers** 1999-2003 2004-2006 2008-2009 **Completed**	Robert Scherpelz *Pacific Northwest National Laboratory-Battelle*	Sergey Romanov *Southern Urals Biophysics Institute*	12	The earlier efforts in this project focused on determining the amount and location of long-term-retained Pu in the lungs of Mayak workers. This completed project was the first to demonstrate very long-term sequestration of Pu particles in human lung parenchyma. Then, this knowledge of Pu distribution in lung was used with state of the art dose assessment methods to modify the human respiratory tract dosimetry models to improve dose assessment. In 2009, the activities of Project 2.5 were merged into Project 2.4, *Mayak Worker Dosimetry*, and the results of the earlier investigations were used in the development of the Mayak Worker Dosimetry System 2008.
2.6	**Molecular Markers of Lung Cancer in Mayak Workers** 2000-2002 2003-2008 **Completed**	Steve Belinsky *Lovelace Respiratory Research Institute*	Vitaly Telnov *Southern Urals Biophysics Institute*	4	The original phase of this completed project demonstrated that the p16 tumor suppressor gene was targeted for inactivation by promoter hypermethylation in plutonium-induced adenocarcinomas of the lung. In the final phase, researchers examined methylation profiles in adenocarcinomas and squamous cell carcinomas of the lung in Mayak workers and controls.
2.7	**Radiation Biomarkers** 2001-2002 2003-2008 **Completed**	David Brenner *Columbia University*	Tamara Azizova *Southern Urals Biophysics Institute*	5	The feasibility study of this completed project indicated a statistically significant dose-response between Pu exposure and intra-arm chromosomal aberrations from worker blood samples. In the final phase, researchers developed a calibrated, dose-related biomarker of Pu exposure.

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2.8	**Mayak Worker Tissue Repository** 1998-2002 2003-2007 2008-2013 2014-2018 2019-2023 **Ongoing**	Christopher Loffredo *Georgetown University*	Evgenia Kirillova *Southern Urals Biophysics Institute*	44	The Mayak Worker Tissue Repository now holds tissues from 2,053 subjects (1,062 from autopsy and 991 from surgery or biopsy) and blood samples (including DNA, serum, plasma, and other blood components) from 7,940 Mayak workers and residents of Ozersk. In conjunction with medical, occupational, and dosimetry information, data collected in the repository will make possible the conduct of molecular epidemiology studies. Such studies combine epidemiologic with genetic/molecular methods to establish an association between disease and radiation exposure in individuals.
2.9	**Database Integration** 2001-2005 **Completed**	Dale Preston *Hirosoft International* Eric Grant *Radiation Effects Research Foundation*	Sergey Romanov *Southern Urals Biophysics Institute*; Evgeny Vasilenko *Mayak Production Association*	0	This completed project successfully combined databases located in two Russian organizations so as to facilitate researcher access to data. As such, it is not intended to result in publications or influence radiation protection standards.

As of December 31, 2019, U.S. and Russian investigators working on projects funded by the Russian Health Studies Program have generated **355** peer-reviewed publications. Of these, **11** were published in 2019.

Russian Health Studies Program
355 Peer Reviewed Publications
December 31, 2019

Project 1.1: Techa River Population Dosimetry (144)

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Project 2.9: Database Integration (0)

None.